SHELL FOUNDATION HEH PROJECT WATER BOILING TEST

DATA AND CALCULATION FORM (the form can be used with stoves that cook between one and four pots)*

Shaded cells require user input; unshaded cells automatically display outputs

Qualitative data

Name(s) of Tester(s)	
Test Number	
Date	
Stove type/model	
Location	
Type of fuel	Average Hardwood
Wind conditions	(Select from list)

*Note, if you are testing a multi-pot stove, the data entry places in the simmering test for pots other than the primary pot are left blank intentionally because the simmering test can not account for pots other than the primary pot.

If possible, enter a locally derived calorific value. Enter the value in cell E19 if the calorific value is for dry fuel (0% MC). Use cell E22 if it is for moist fuel. If a local calorific value can not be obtained, choose the closest fuel from this menu.

Initial Test Conditions

Data	value	units	label	Data	value	units	label
Air temp		ºC		Dry weight of Pot # 1 (grams)	1,000	g	P1
Average dimensions of fuel (if solid)		cm x cm x cm		Dry weight of Pot # 2 (grams)	1,000	g	P2
Gross calorific value (dry fuel)	19,734	kJ/kg	HHV	Dry weight of Pot # 3 (grams)		g	P3
Net calorific value (dry fuel)	18,414	kJ/kg	LHV	Dry weight of Pot # 4 (grams)		g	P4
Wood moisture content (% - wet basis)	20%	%	m	Weight of container for char (grams)	50	g	k
Effective calorific value (accounting for fuel moisture)	14,195	kJ/kg	c_{eff}	Local boiling point	100.0	ºC	T_b

Description of stove and other comments:	

BASIC TEST DATA

		COLD START HIGH POWER				HOT START HIGH POWER (OPTIONAL)				SIMMER TEST			
		Start		Finish: when Pot #1 boils		Start		Finish: when Pot #1 boils		Start:when Pot #1 boils		Finish: 45 min after Pot #1 boils	
Measurements	Units	data	label	data	label	data	label	data	label	data	label	data	label
Time (in 24 hour units)	hr:min	12:00	t_{ci}	12:30	t_{cf}		t_{hi}		t_{hf}		t_{si}		t_{sf}
Weight of wood	g	2500	f_{ci}	1500	f_{cf}		f_{hi}		f_{hf}		f_{si}		f_{sf}
Water temperature, Pot # 1	ºC	20.0	$T1_{ci}$	100.0	$T1_{cf}$		$T1_{hi}$		$T1_{hf}$		$T1_{si}$		$T1_{sf}$
Water temperature, Pot # 2	ºC	20.0	$T2_{ci}$	75.0	$T2_{cf}$		$T2_{hi}$		$T2_{hf}$				
Water temperature, Pot # 3	ºC	20.0	$T3_{ci}$	50.0	$T3_{cf}$		$T3_{hi}$		$T3_{hf}$				
Water temperature, Pot # 4	ºC		$T4_{ci}$		$T4_{cf}$		$T4_{hi}$		$T4_{hf}$				
Weight of Pot # 1 with water	g	6000	$P1_{ci}$	5700	$P1_{cf}$		$P1_{hi}$		$P1_{hf}$		$P1_{si}$		$P1_{sf}$
Weight of Pot # 2 with water	g	6000	$P2_{ci}$	5950	$P2_{cf}$		$P2_{hi}$		$P2_{hf}$				
Weight of Pot # 3 with water	g		$P3_{ci}$		$P3_{cf}$		$P3_{hi}$		$P3_{hf}$				
Weight of Pot # 4 with water	g		$P4_{ci}$		$P4_{cf}$		$P4_{hi}$		$P4_{hf}$				
Fire-starting materials (if any)	--												
Weight of charcoal+container	g			100	c_c				c_h				c_s

$T1_{si}$ is set equal to T_b because the simmer test starts after the pot has boiled.

$P1_{si}$ should be the mass remaining in pot one at the end of the hot start test ($P1_{hf}$).

		COLD START		**HOT START**	
Calculations/Results	Units	data	label	data	label
Wood consumed (moist)	g	1,000	f_{cm}	-	f_{hm}
Net change in char during test	g	50	Δc_c	-	Δc_h
Equivalent dry wood consumed	g	701	f_{cd}	-	f_{hd}
Water vaporized from all pots	g	350	w_{cv}	-	w_{hv}
Effective mass of water boiled	g	8,103	w_{cr}	-	w_{hr}
Time to boil Pot # 1	min	29	Δt_c	-	Δt_h
Temp-corr time to boil Pot # 1	min	27	Δt^T_c	-	Δt^T_h
Thermal efficiency	%	28%	h_c		h_h
Burning rate	g/min	24	r_{cb}	-	r_{hb}
Specific fuel consumption	g/liter	87	SC_c	-	SC_h
Temp-corr sp consumption	g/liter	81	SC^T_c	-	SC^T_h
Firepower	watts	7,376	FP_c	-	FP_h

SIMMER TEST (CALCULATIONS DIFFER FROM HIGH POWER TEST)

Calculations/Results	Units	data	label
Wood consumed during the simmer phase (mc	g	-	f_{sm}
Net change in char during test phase	g	-	Δc_s
Equivalent dry wood consumed	g	-	f_{sd}
Water vaporized	g	-	w_{sv}
Water remaining at end - Pot # 1	g	-	w_{sr}
Time of simmer (should be ~45 minutes)	min	-	Δt_s
Thermal efficiency	%		h_s
Burning rate	g/min	-	r_{sb}
Specific fuel consumption	g/liter	-	SC_s
Firepower	watts	-	FP_s
Turn down ratio	--	-	TDR

HOT START, COLD START, AND SIMMER TESTS

Comments on the High Power - Cold Start Test:

Comments on the High Power - Hot Start Test:

Comments on the Low Power/Simmer Test:

COMMENTS

SHELL FOUNDATION HEH PROJECT WATER BOILING TEST

DATA AND CALCULATION FORM (the form can be used with stoves that cook between one and four pots)*

Shaded cells require user input; unshaded cells automatically display outputs

Qualitative data

Name(s) of Tester(s)	
Test Number	
Date	
Stove type/model	
Location	
Type of fuel	(Select from list)
Wind conditions	(Select from list)

*Note, if you are testing a multi-pot stove, the data entry places in the simmering test for pots other than the primary pot are left blank intentionally because the simmering test can not account for pots other than the primary pot.

If possible, enter a locally derived calorific value. Enter the value in cell E19 if the calorific value is for dry fuel (0% MC). Use cell E22 if it is for moist fuel. If a local calorific value can not be obtained, choose the closest fuel from this menu.

Initial Test Conditions

Data	value	units	label	Data	value	units	label
Air temp		ºC		Dry weight of Pot # 1 (grams)		g	P1
Average dimensions of fuel (if solid)		cm x cm x cm		Dry weight of Pot # 2 (grams)		g	P2
Gross calorific value (dry fuel)	-	kJ/kg	HHV	Dry weight of Pot # 3 (grams)		g	P3
Net calorific value (dry fuel)	-	kJ/kg	LHV	Dry weight of Pot # 4 (grams)		g	P4
Wood moisture content (% - wet basis)		%	m	Weight of container for char (grams)		g	k
Effective calorific value (accounting for fuel moisture)	-	kJ/kg	c_{eff}	Local boiling point		ºC	T_b

Description of stove and other comments:	

BASIC TEST DATA

		COLD START HIGH POWER				HOT START HIGH POWER (OPTIONAL)				SIMMER TEST			
		Start		Finish: when Pot #1 boils		Start		Finish: when Pot #1 boils		Start:when Pot #1 boils		Finish: 45 min after Pot #1 boils	
Measurements	Units	data	label	data	label	data	label	data	label	data	label	data	label
Time (in 24 hour units)	hr:min		t_{ci}		t_{cf}		t_{hi}		t_{hf}		t_{si}		t_{sf}
Weight of wood	g		f_{ci}		f_{cf}		f_{hi}		f_{hf}		f_{si}		f_{sf}
Water temperature, Pot # 1	ºC		$T1_{ci}$		$T1_{cf}$		$T1_{hi}$		$T1_{hf}$		$T1_{si}$		$T1_{sf}$
Water temperature, Pot # 2	ºC		$T2_{ci}$		$T2_{cf}$		$T2_{hi}$		$T2_{hf}$				
Water temperature, Pot # 3	ºC		$T3_{ci}$		$T3_{cf}$		$T3_{hi}$		$T3_{hf}$				
Water temperature, Pot # 4	ºC		$T4_{ci}$		$T4_{cf}$		$T4_{hi}$		$T4_{hf}$				
Weight of Pot # 1 with water	g		$P1_{ci}$		$P1_{cf}$		$P1_{hi}$		$P1_{hf}$		$P1_{si}$		$P1_{sf}$
Weight of Pot # 2 with water	g		$P2_{ci}$		$P2_{cf}$		$P2_{hi}$		$P2_{hf}$				
Weight of Pot # 3 with water	g		$P3_{ci}$		$P3_{cf}$		$P3_{hi}$		$P3_{hf}$				
Weight of Pot # 4 with water	g		$P4_{ci}$		$P4_{cf}$		$P4_{hi}$		$P4_{hf}$				
Fire-starting materials (if any)	--												
Weight of charcoal+container	g				c_c				c_h				c_s

$T1_{si}$ is set equal to T_b because the simmer test starts after the pot has boiled.

$P1_{si}$ should be the mass remaining in pot one at the end of the hot start test ($P1_{hf}$).

		COLD START		**HOT START**	
Calculations/Results	Units	data	label	data	label
Wood consumed (moist)	g	-	f_{cm}	-	f_{hm}
Net change in char during test	g	-	Δc_c	-	Δc_h
Equivalent dry wood consumed	g	-	f_{cd}	-	f_{hd}
Water vaporized from all pots	g	-	w_{cv}	-	w_{hv}
Effective mass of water boiled	g	-	w_{cr}	-	w_{hr}
Time to boil Pot # 1	min	-	Δt_c	-	Δt_h
Temp-corr time to boil Pot # 1	min	-	Δt^T_c	-	Δt^T_h
Thermal efficiency	%		h_c		h_h
Burning rate	g/min	-	r_{cb}	-	r_{hb}
Specific fuel consumption	g/liter	-	SC_c	-	SC_h
Temp-corr sp consumption	g/liter	-	SC^T_c	-	SC^T_h
Firepower	watts	-	FP_c	-	FP_h

SIMMER TEST (CALCULATIONS DIFFER FROM HIGH POWER TEST)			
Calculations/Results	Units	data	label
Wood consumed during the simmer phase (mc	g	-	f_{sm}
Net change in char during test phase	g	-	Δc_s
Equivalent dry wood consumed	g	-	f_{sd}
Water vaporized	g	-	w_{sv}
Water remaining at end - Pot # 1	g	-	w_{sr}
Time of simmer (should be ~45 minutes)	min	-	Δt_s
Thermal efficiency	%		h_s
Burning rate	g/min	-	r_{sb}
Specific fuel consumption	g/liter	-	SC_s
Firepower	watts	-	FP_s
Turn down ratio	--	-	TDR

HOT START, COLD START, AND SIMMER TESTS

Comments on the High Power - Cold Start Test:

Comments on the High Power - Hot Start Test:

Comments on the Low Power/Simmer Test:

COMMENTS

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Test Number	
Date	
Stove type/model	
Location	
Type of fuel	(Select from list)
Wind conditions	(Select from list)

*Note, if you are testing a multi-pot stove, the data entry places in the simmering test for pots other than the primary pot are left blank intentionally because the simmering test can not account for pots other than the primary pot.

If possible, enter a locally derived calorific value. Enter the value in cell E19 if the calorific value is for dry fuel (0% MC). Use cell E22 if it is for moist fuel. If a local calorific value can not be obtained, choose the closest fuel from this menu.

Initial Test Conditions

Data	value	units	label	Data	value	units	label
Air temp		ºC		Dry weight of Pot # 1 (grams)		g	P1
Average dimensions of fuel (if solid)		cm x cm x cm		Dry weight of Pot # 2 (grams)		g	P2
Gross calorific value (dry fuel)	-	kJ/kg	HHV	Dry weight of Pot # 3 (grams)		g	P3
Net calorific value (dry fuel)	-	kJ/kg	LHV	Dry weight of Pot # 4 (grams)		g	P4
Wood moisture content (% - wet basis)		%	m	Weight of container for char (grams)		g	k
Effective calorific value (accounting for fuel moisture)	-	kJ/kg	c_{eff}	Local boiling point		ºC	T_b

Description of stove and other comments:	

BASIC TEST DATA

		COLD START HIGH POWER				HOT START HIGH POWER (OPTIONAL)				SIMMER TEST			
		Start		Finish: when Pot #1 boils		Start		Finish: when Pot #1 boils		Start:when Pot #1 boils		Finish: 45 min after Pot #1 boils	
Measurements	Units	data	label	data	label	data	label	data	label	data	label	data	label
Time (in 24 hour units)	hr:min		t_{ci}		t_{cf}		t_{hi}		t_{hf}		t_{si}		t_{sf}
Weight of wood	g		f_{ci}		f_{cf}		f_{hi}		f_{hf}		f_{si}		f_{sf}
Water temperature, Pot # 1	ºC		$T1_{ci}$		$T1_{cf}$		$T1_{hi}$		$T1_{hf}$		$T1_{si}$		$T1_{sf}$
Water temperature, Pot # 2	ºC		$T2_{ci}$		$T2_{cf}$		$T2_{hi}$		$T2_{hf}$				
Water temperature, Pot # 3	ºC		$T3_{ci}$		$T3_{cf}$		$T3_{hi}$		$T3_{hf}$				
Water temperature, Pot # 4	ºC		$T4_{ci}$		$T4_{cf}$		$T4_{hi}$		$T4_{hf}$				
Weight of Pot # 1 with water	g		$P1_{ci}$		$P1_{cf}$		$P1_{hi}$		$P1_{hf}$		$P1_{si}$		$P1_{sf}$
Weight of Pot # 2 with water	g		$P2_{ci}$		$P2_{cf}$		$P2_{hi}$		$P2_{hf}$				
Weight of Pot # 3 with water	g		$P3_{ci}$		$P3_{cf}$		$P3_{hi}$		$P3_{hf}$				
Weight of Pot # 4 with water	g		$P4_{ci}$		$P4_{cf}$		$P4_{hi}$		$P4_{hf}$				
Fire-starting materials (if any)	--												
Weight of charcoal+container	g				c_c				c_h				c_s

$T1_{si}$ is set equal to T_b because the simmer test starts after the pot has boiled.

$P1_{si}$ should be the mass remaining in pot one at the end of the hot start test ($P1_{hf}$).

		COLD START		**HOT START**	
Calculations/Results	Units	data	label	data	label
Wood consumed (moist)	g	-	f_{cm}	-	f_{hm}
Net change in char during test	g	-	Δc_c	-	Δc_h
Equivalent dry wood consumed	g	-	f_{cd}	-	f_{hd}
Water vaporized from all pots	g	-	w_{cv}	-	w_{hv}
Effective mass of water boiled	g	-	w_{cr}	-	w_{hr}
Time to boil Pot # 1	min	-	Δt_c	-	Δt_h
Temp-corr time to boil Pot # 1	min	-	Δt^T_c	-	Δt^T_h
Thermal efficiency	%		h_c		h_h
Burning rate	g/min	-	r_{cb}	-	r_{hb}
Specific fuel consumption	g/liter	-	SC_c	-	SC_h
Temp-corr sp consumption	g/liter	-	SC^T_c	-	SC^T_h
Firepower	watts	-	FP_c	-	FP_h

SIMMER TEST (CALCULATIONS DIFFER FROM HIGH POWER TEST)			
Calculations/Results	Units	data	label
Wood consumed during the simmer phase (mc	g	-	f_{sm}
Net change in char during test phase	g	-	Δc_s
Equivalent dry wood consumed	g	-	f_{sd}
Water vaporized	g	-	w_{sv}
Water remaining at end - Pot # 1	g	-	w_{sr}
Time of simmer (should be ~45 minutes)	min	-	Δt_s
Thermal efficiency	%		h_s
Burning rate	g/min	-	r_{sb}
Specific fuel consumption	g/liter	-	SC_s
Firepower	watts	-	FP_s
Turn down ratio	--	-	TDR

HOT START, COLD START, AND SIMMER TESTS

Comments on the High Power - Cold Start Test:

Comments on the High Power - Hot Start Test:

Comments on the Low Power/Simmer Test:

COMMENTS

Results of three water boiling tests - <u>all cells are linked to data worksheets, no entries are required</u>

Stove type/model

Location

Wood species (specify if different for each test) Average Hardwood

Wind conditions (specify if different for each test) (Select from list)

1. HIGH POWER TEST (COLD START)	units	Test 1	Test 2	Test 3	Average	St Dev
Time to boil Pot # 1	min	29	-	-	29.2	-
Temp-corrected time to boil Pot # 1	min	27	-	-	27.3	-
Burning rate	g/min	24	-	-	24.0	-
Thermal efficiency	%	28%	0%	0%	28%	0%
Specific fuel consumption	g/liter	87	-	-	86.5	-
Temp-corrected specific consumption	g/liter	81	-	-	81.1	-
Firepower	watts	7,376	-	-	7376	-

2. HIGH POWER TEST (HOT START)	units	Test 1	Test 2	Test 3	Average	St Dev
Time to boil Pot # 1	min	-	-	-	0.0	-
Temp-corrected time to boil Pot # 1	min	-	-	-	0.0	-
Burning rate	g/min	-	-	-	0.0	-
Thermal efficiency	%	0%	0%	0%	0%	0%
Specific fuel consumption	g/liter	-	-	-	0.0	-
Temp-corrected specific consumption	g/liter	-	-	-	0.0	-
Firepower	watts	-	-	-	0	-

3. LOW POWER (SIMMER)	units	Test 1	Test 2	Test 3	Average	St Dev
Burning rate	g/min	-	-	-	0.0	-
Thermal efficiency	%	0%	0%	0%	0%	0%
Specific fuel consumption	g/liter	-	-	-	0.0	-
Firepower	watts	-	-	-	0	-
Turn down ratio	--	-	-	-	0.00	-

Use this worksheet if you are determining fuel moisture with the Delmhorst J-2000 or similar handheld moisture meter. If you are using another means to determine fuel moisture, ignore this worksheet and enter the moisture in the proper space on each Test's data form.

To find fuel moisture, take 3 pieces of fuel at random from the stock used for each test and measure each in three places along its length. Enter the results in the spaces below. The worksheet will authmatically calculate average moisture content on a dry and wet basis.

Test-1 Instrument reading (% dry basis)

	1	2	3
Piece 1			
Piece 2			
Piece 3			

Average moisture content (%)

dry-basis ____ wet-basis ____

Test-2 Instrument reading (% dry basis)

	1	2	3
Piece 1			
Piece 2			
Piece 3			

Average moisture content (%)

dry-basis ____ wet-basis ____

The Delmhorst J-2000 moisture analyzer measures fuel moisture on a dry basis. To find moisture on a wet basis, simply use the following calculation:

$$MC_{wet} = \frac{MC_{dry}}{1 + MC_{dry}}$$

This spreadsheet does this calculation automatically. Output from the HH data and results worksheet requires moisture content on a wet basis, so the conversion is very important.

Test-3 Instrument reading (% dry basis)

	1	2	3
Piece 1			
Piece 2			
Piece 3			

Average moisture content (%)

dry-basis ____ wet-basis ____

Fuel moisture content worksheet

wind conditions

(Select from list)	1
No wind	2
Light breeze	3
Moderate wind	4
Strong wind	5
Very strong wind	6
	7
	8
	9
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	49

Tree species

(Select from list)
LPG
Kerosene
Charcoal
Coal
Crop residues
Dung
Average Hardwood
Average Softwood (Conifer)
Abies Balsamea (Balsam Fir)
Acacia Auriculiformis (Ear-Leaf Acacia, Ear-Pod Wattle)
Acacia Decurrens (King Wattle, Green Wattle, Sydney Black Wattle)
Acacia Farnesiana (Sweet Acacia, Sweet Wattle)
Acacia Leucophloea (Kikar, Kuteeera Gum)
Acacia Mearnsi (Black Wattle)
Acacia Nilotica (Egyptian Thorn, Babul (India), Babar (Pakistan))
Acacia Tortilis (Umbrella Thorn)
Acer Rubrum (Red Maple)
Albizia Falcataria (Batai, Malucca Albizia, ,Placata)
Albizia Lebbek (Lebbek, East Indian Walnut Tree)
Albizia Procera (Albicia, Silver Bark Rain Tree)
Alnus Nepalensis (Nepal Alder)
Alnus Rubra (Red Alder)
Alnus Rubra (Red Alder)
Alstonia Macrophylla (Devil Tree)
Anogeissus Latifolia (Axle-Wood Tree, Dhausa (Hindi))
Anthocephalus Cadamba (Labula (Indonesia))
Antidesma Ghaessimbilla
Avicennia Officinalis (Mangrove, Api-Api Sudu (Philippines))
Balanites Aegyptiaca (Desert Date, Thorn Tree, Soapberry Tree)
Bruguiera Gymnorrhiza (Black Mangrove, Large-Leafed Mangrove)
Bruguiera Parviflora (Thua Shale, Slender-Fruited Orange Mangrove)
Bruguiera Sexangula (Orange Mangrove)
Calliandra Calothyrsus (Calliandra)
Carya Spp (Hickory)
Cassia Fistula (Cassia Stick Tree, Guayaba Cimarrona, Canafistula, Golden Shower, Indian Laburnum, Baton Ca
Cassia Siamea (Siamese Cassia)
Casuarina Equistofolia (Casuarina, She-Oak, Whistling Pine)
Ceriops Tagal (Tagal Mangrove, Kandal)
Cocus Nucifera (Coconut Palm)
Cordia Dichotoma (Anunang (Philippines), Bird Lime Tree)
Dalbergia Latifolia (East Indian Rosewood, Malabar Rosewood, Sitsal, Beete, Shisham)
Dalbergia Sissoo (Sissoo, Shisham, Karra, Shewa)
Derris Indica (India: Pongam, Ponga, Kona, Kanji, Karanja, Karanda; English: Indian Beech)
Diospyros Philippinensis (Kamagong (Philippines))
Diospyros Philosanthera (Bolong-Eta (Philippines))
Emblica Ofiicinalis (Madre De Cacao, Kakauati (Philippines), Mexican Lilac, Madera Negra)
Eucalyptus Camaldulensis (Red River Gum, Red Gum)
Eucalyptus Deglupta (Rainbow Gum Tree)

Eucalyptus Globulus (Southern Blue Gum, Fever Tree)
Eucalyptus Grandis (Rose Gum, Grand Eucalyptus)
Fagus Spp (Beech)
Gigantochloa Apus (Pring Tali, Tabasheer Bamboo)
Gliricidia Sepium
Gmelina Arborea (Gmelina, Gumhar (India))
Lagerstroemia Speciosa (Queen's Crape Myrtle, Giant Crape Myrtle)
Leucaena Leucocephala (Leucaena, Ipil-Ipil (Philippines), Uaxin (Latin America), Lamtora (Indonesia), Lead Tree)
Melia Azedarach (China Berry, Persian Lilac, Bead Tree, Cape Lilac)
Pinus Elliotii (Southern Pine)
Pinus Ponderosa (Ponderosa Pine)
Pithecellobium Dulce (Quamachil, Guamuchil (Mexico), Manila Tamarind)
Platanus Occidentalis (Sycamore)
Populus Euphratica (Euphrates Poplar, Saf-Saf, Indian Poplar)
Populus Trichocarpa (Black Cottonwood)
Prosopis Cineraria (Jand, Khejri (India))
Prosopis Pallida (Kiawe)
Pseudotsuga Menziesii (Douglas Fir)
Psidium Guajava (Guava, Guayaba)
Quercus Bicolor (White Oak)
Quercus Rubra (Red Oak)
Rhizophera Spp (Mangrove Spp (Also *Avicennia Spp*))
Sapium Sebiferum (Chinese Tallow Tree, Soap Tree, Tarchabi (Pahari) Shishum (India))
Schima Noronhae
Schleichera Oleosa (Kosambi (Indonesia), Lac Tree)
Sesbania Grandiflora (Scarlet Wisteria Tree, Agati, Corkwood Tree, West Indian Pea)
Swietenia Macrophylla (Brazilian Mahogany, Caoba, Honduras Mahogany, Big Leaf Mahogany)
Syzygium Cumini (Jambolan, Java Plum)
Thuja Plicata (Western Red Cedar)
Trema Spp
Tsuga Canadensis (Eastern Hemlock)
Tsuga Heterophylla (Western Hemlock)
Ulmus Spp (Elm)
Xylocarpus Granatum (Cannonball Mangrove, Cedar Mangrove)
Xylocarpus Moluccensis (Cedar Mangrove)
Zizyphus Mauritania (Indian Jujube, Indian Plum)
Zizyphus Talanai

Statisti
Minimum
Maximum
standard Deviation
Average
Percentiles: 25th
50th
75th

NAS (1980). Firewood Crops. Washington DC, National Academy of Sciences.
Cheremisinoff, N. (1980). Properties of Wood. Wood for Energy Production. Ann Arbor, MI, Ann Arbor Science: 31-43.

Harker, A. P., A. Sandels, et al. (1982). Calorific values for wood and bark and a bibliography for fuelwood. London, Tropical Products Institute: 20.

FAO (1993). Energy and Environment Basics. Bangkok, Regional Wood Energy Development Program (RWEDP): 85.

kJ/kg	Source	Fuel	Calorific value (MJ/kg)	
		Kerosene		43.3
	--			43.6
48,000				43.1
43,300		LPG		49
29,400				47.1
24,700				45.8
14,700				50.1
13,600		Natural gas		51.3
19,734	3			
20,817	3	Biogas		17.7
18,916	2			
20,370	1			
18,700	4	Fuel	Calorific value (MJ/kg)	
19,200	4	Charcoal		25.7 @ 1.7 % MCwet
21,800	4			27.6 @ ~5 % MCwet
19,530	1			29.2 @ ~5 % MCwet
20,475	1			30 @ ~5 % MCwet
18,480	1			30.7 @ ~5 % MCwet
18,545	2			31.1 @ ~5 % MCwet
18,100	4			31.5 @ ~5 % MCwet
21,840	1	Maize stalks		16.1 @ 9.1 % MCwet
19,700	4			15.4 @ 5.0 % MCwet
17,150	4	Wheat stalks		14 @ 7.3 % MCwet
19,320	1			15.4 @ 5.0 % MCwet
18,545	2	Rice stalks		13 @ 8.8 % MCwet
19,200	4			14.2 @ 5.0 % MCwet
20,580	1	Dung		11.8 @ 7.3 % MCwet
19,350	4			15.4 @ 5.0 % MCwet
19,100	4	Coal		
18,500	4	China		22.5
19,320	1	China		27.3 @ 2.1 % MCwet
20,400	4	China (washed)		30.1 @ 4.7 % MCwet
18,700	4	US		26.2
19,400	4	India		18.4
19,425	1	South Africa		23.5
18,684	2			
18,400	4			
18,800	4			
20,790	1			
19,600	4			
19,000	4			
18,400	4			
19,800	4			
21,210	1			
19,320	1			
18,600	4			
18,100	4			
21,840	1			
20,160	1			
18,700	4			

20,160	1
19,750	4
18,916	2
18,400	4
20,580	1
20,160	1
19,300	4
18,480	1
21,460	1
19,961	2
18,684	2
22,680	1
18,545	2
21,057	1
20,425	2
21,000	1
19,750	4
20,634	2
20,126	1
18,916	2
18,684	2
17,430	1
17,663	1
20,000	4
18,700	4
19,300	4
20,700	4
20,160	1
22,514	2
18,900	1
19,520	2
19,520	2
18,963	2
16,300	4
15,400	4
20,580	1
18,300	4

cal Summary

15,400
22,680
1,281
19,483
18,684
19,320
20,370

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Source
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